

11. HPC SPECIFICATIONS

VIRGINIA DEPARTMENT OF TRANSPORTATION SPECIAL PROVISION FOR LOW PERMEABILITY CONCRETES

August 29, 1994
Rev: May 21, 1996c

SECTION 217 of the Specifications is amended as follows:

Section 217.02(a) is replaced with the following:

Cement shall conform to the requirements of Section 214 and shall be Type II with a maximum alkali content of 0.40% or Type I-P, unless otherwise permitted herein or otherwise specified in the contract. Fly ash or granulated iron blast-furnace slag shall not be added to concrete when Type I-P cement is used. Fly ash, granulated iron blast-furnace slag, silica fume, or other approved mineral admixtures shall be used with Types I, II (if above 0.40% alkali content) or III cements as specified herein.

Types I, II, and III cements may be used with latex modified portland cement concrete, however latex will not be permitted in Class A5 concrete.

Granulated iron blast-furnace slag shall replace from 35% to 50% by weight of the design cement content.

Other mineral admixtures shall be used in accordance with the requirements shown on the approved list of mineral admixtures.

Section 217.02 is amended to replace (h) and (i) with the following:

(h) **Fly ash** shall conform to the requirements of Section 241. Class F fly ash shall be between 20% and 25% by mass of the cementitious material. However, no more than 15% of the portland cement of a standard mixture shall be replaced.

(i) **Granulated iron blast-furnace slag** shall conform to the requirements of Section 215.

Section 217.02 is amended to add the following:

(k) **Silica fume** shall conform to the requirements of AASHTO M307 or ASTM C1240. Silica fume shall replace between 7% and 10% by mass of the cementitious material. Only silica fume at the rate of 3% to 7% may be added to all combinations to reduce the early permeability after the approval of the Engineer.

Section 217.08 is amended to add the following:

(c) Quality Assurance for Low Permeability Concrete (for Concrete in Bridges Only):

General:

At least two trial batches (using job materials) with permissible combination of cementitious materials shall be prepared, and test specimens shall be cast by the contractor and tested by the Department for permeability and strength at least a month before the field application. The permeability samples shall be cylindrical specimens with a 100-mm (4-in) diameter and at least 100-mm (4-in) in length. They shall be moist cured as the strength cylinders for acceptance except that the last 3 weeks of cure shall be at $38\text{ }^{\circ}\text{C} \pm 6\text{ }^{\circ}\text{C}$ ($100\text{ }^{\circ}\text{F} \pm 10\text{ }^{\circ}\text{F}$). Cylinders shall be tested at 28 days in accordance with AASHTO T 277 or ASTM C 1202. The test value shall be the result of the average values of tests on two specimens from each batch. Permeability values obtained from trial batches shall be 500 coulombs below the maximum values specified in Table II-17.

Acceptance Tests:

A quality assurance and acceptance procedure that provides for periodic tests of the field concrete for permeability using AASHTO T 277, shall be established. This should include provisions for testing frequency; the range of coulomb values for which full or partial payments would be made; and the values that would require corrective measures to be taken (or rejection of the concrete) should be stated. The following are quality assurance procedures for field evaluations.

A lot shall be a day's production of concrete for the job and shall be used for statistical acceptance procedure for bridge concrete. For each set of cylinders made for compressive strength tests, two additional cylinders shall be made for the permeability test.

For all classes of concrete, initially one set of permeability cylinders shall be tested for each lot in accordance with AASHTO T 277. If the average coulomb value for this test is less than the coulomb value shown in Table II-17, the lot will be accepted at the full bid price.

If the average test result exceeds the coulomb value in Table II-17, payment for the concrete in that element (in-place cost) shall be reduced 0.02 percent for each coulomb above the coulomb value in Table II-17, however, the reduction in price will not exceed 20% of the bid price of the concrete. Concrete with a coulomb value that exceeds the maximum required in Table II-17 by 1000 coulomb will be rejected. However, bridge deck with the coulomb value exceeding the maximum required by

over 1000 coulomb may be accepted by the Engineer at 80% of the bid price if it has the required strength and meets other specification requirements, and the contractor applies, at his own expense, an approved epoxy concrete overlay to the top of the deck. In such case deck grooving will not be required. The adjustment to the roadway grade shall be made as required by the Engineer at the Contractor's expense.

Similarly, concrete in abutments and pier caps with coulomb value exceeding the maximum required in Table II-17, by more than 1000 coulomb may be accepted at 80% of the bid price if it has the required strength and meets other specification requirements, and the contractor applies at his own expense, an approved epoxy, conforming to Type EP-3B and EP-3T (of Section 243.02), on top of the pier cap or abutment seat.

The reduction in the bid prices mentioned above shall be applied to the total volume of concrete in bridge members (deck slab of a single span, deck slab of a group of continuous spans, pier or abutment) for which any portion of the concrete in the member did not meet the permeability test requirements.

Section 404.03(k) Curing Concrete is amended to add the following:

Section 404.03(k)1. Curing Bridge Deck and Overlay Concrete: Bridge deck and overlay concrete, including latex modified concrete, shall be moist cured for a minimum of 7 days and until 70% **f'c** is reached. Moist curing shall be maintained by wet burlap (keep wet) for the duration of the curing and covered with plastic sheeting. Immediately after screeding and until the application of wet burlap and white plastic sheeting (opaque and transparent sheeting may be used when the air temperature falls below 10 °C (50 °F)), no surface of the freshly placed concrete shall be allowed to dry. During moist curing, the concrete temperature shall be maintained above 10 °C (50 °F) at the outer most surfaces of the concrete mass. Immediately after removing the burlap and plastic sheeting (except for latex-modified concrete), white pigmented curing compound shall be applied while the surface is damp but has no free water standing on it. The application rate shall be 2.4 - 3.6 square meters per liter (100 to 150 sq.ft./gal.).

Section 404.03(l) 1. Weather is amended to replace the 4th paragraph with the following:

Protection shall be provided to prevent rapid drying of concrete as a result of low humidity, high wind, high atmospheric temperatures, or combinations thereof. For bridge deck and overlay concretes, fogging with pressure sprayers sufficient to maintain a moist surface shall be required. The protective measures taken shall maintain an evaporation rate at or below 0.5 kg/sq m/hr (0.10 lb/sq ft/hr) for bridge deck concrete and 0.3 kg/sq m/hr (0.05 lb/sq ft/hr) for concrete overlays. The Contractor

shall determine the evaporation rate and take appropriate action. Other preventative measures described in ACI 308 can also be used in addition to fogging. Evaporation retardant films may be applied in a fine mist immediately after screeding to ensure that the surface remains wet until covered. If such materials are used, they shall not be intermixed with the surface mortar. Placement of concrete shall be regulated at a rate such that the finishing operations are able to be completed and the wet burlap and polyethylene sheeting are placed prior to any drying of the concrete.

Section 404.03 is amended to add the following:

- (n) **Defective Concrete:** All defective or damaged concrete which occurs prior to the final acceptance of the work shall be repaired or replaced at the Contractor's expense. Defects shall include, but not be limited to, cracking, tearing, and damage or other imperfections.

All visible cracks and construction joints in bridge deck concretes shall be sealed by the contractor using an approved polymer. Concrete shall be at least 28 days old and dry before the application of the polymer. Concrete shall be grooved after the application of the polymer.

Section 404.04 is amended to add the following:

Consolidation: In deck placements, internal vibrators and screeds with vibrating element shall be used. The minimum frequency of the vibrating element shall be 3,000 vibrations per minute. Internal vibration shall be required along the transverse and longitudinal edges and joints, and where the thickness of concrete exceeds 75 mm (3 in).

Section 405.02(a) is amended to add the following:

Prestressed concrete in structures other than those over tidal water shall contain 15 l/m³ (3 gal/yd³) of calcium nitrite only if the coulomb value of the concrete exceeds 1500. Prestressed concrete for structures over tidal water shall contain either 25l/m³ (5.0 gal/yd³) of calcium nitrite if the coulomb value of concrete exceeds 1,500 or 10 l/m³ (2.0 gal/yd³) of calcium nitrite if the coulomb value of concrete is 1,500 or less.

Section 405.05(c) is amended to replace the last sentence with the following:

Both internal vibrators and external form vibrators shall be used for concrete with strength equal or exceeding 55 MPa (8000 psi). The use of external vibration for other concrete will be at the option of the Contractor with approval of the Engineer. Improper placing and vibrating may be cause for rejection.

Section 405.05(f)4. is completely replaced by the following:

The temperature rise in the curing enclosure shall be uniform, with a rate rise of not more than 27 °C (80°F) per hour. Concrete shall be cured at a steam temperature of not more than 82 °C (180°F), with the steam temperature uniform throughout the curing enclosure, and with a variation of not more than -7 °C (20°F). Maximum concrete temperature during the curing cycle shall be 88 °C (190°F). Approved recording thermometers shall be placed so that temperatures can be recorded at a minimum of two locations spaced at or near the third of the length in each curing enclosure and at least one sensor shall measure the temperature in the concrete.

TABLE II-17 Requirements for Hydraulic Cement Concrete of the Specifications is replaced by the following:

TABLE II-17
Requirements for Hydraulic Cement Concrete
(English Units)

Class of Concrete	Design Min. Laboratory Compressive Strength at 28 Days (f'c) (psi)	Design Max. Laboratory Permeability at 28 Days (Coulombs)	Nominal Max. Aggregate Size (in)	Min. Cementitious Content (lb/cu yd)	Max. Water/Cementitious Mat. (lb Water/lb Cement)	Consistency (in of slump)	Air Content (%) ¹
A5 Prestressed and other special designs ²	5,000 or as specified on the plans	1,500	1	635	0.40	0-4	4 1/2 +/- 1 1/2
A4.5	4,500	2,500	1	635	0.45	2-4	6 1/2 +/- 1 1/2
A4 General	4,000	2,500	1	635	0.45	2-4	6 1/2 +/- 1 1/2
A4 Post & rails ³	4,000	2,500	0.5	635	0.45	2-5	7 +/- 2
A3 General	3,000	3,500	1	588	0.45	1-5	6 +/- 2
A3 Paving	3,000	3,500	1	564	0.49	0-3	6 +/- 2
B2 Massive or lightly reinforced	2,200	N.A.	1	494	0.58	0-4	4 +/- 2
C1 Massive Unreinforced	1,500	N.A.	1	423	0.71	0-3	4 +/- 2
T3 Tremie seal	3,000	N.A.	1	635	0.49	3-6	4 +/- 2
Latex hydraulic cement concrete overlay ⁴	3,500	1,500	0.5	658	0.40	4-6	5 +/- 2
Silica fume concrete overlay	5,000	1,500	0.5	658 ⁵	0.40	4-7	6 +/- 2

¹ When a high-range water reducer is used, the target air content shall be increased 1% and the slump shall not exceed 7 inches.

² When Class A5 concrete is used as the finishing bridge deck riding surface, or when it is to be covered with asphalt concrete with or without waterproofing, the air content shall be 5 1/2 +/- 1 1/2%.

³ When necessary for ease in placement, aggregate No. 7 shall be used in concrete posts, rails, and other thin sections above the top of bridge deck slabs.

⁴ The latex modifier content shall be 3.5 gallons per bag of cement. Slump shall be measured approximately 4.5 minutes after discharge from the mixer.

⁵ Minimum 7% silica fume replacement by weight of the total cementitious material.

Note: Contractor may substitute a higher class of concrete for that specified at his expense.

TABLE II-17
Requirements for Hydraulic Cement Concrete
(Metric units)

Class of Concrete	Design Min. Laboratory Compressive Strength at 28 Days (MPa)	Design Max. Laboratory Permeability at 28 Days (Coulombs)	Nominal Max. Aggregate Size (mm)	Min. Cementitious Content (kg/cu m)	Max. Water/Cementitious Mat. (kg Water/kg Cement)	Consistency (mm of slump)	Air Content (%) ¹
A35 Prestressed and other special designs ²	35 or as specified on the plans	1,500	25	375	0.40	0-100	4 1/2 +/- 1 1/2
A30 General	30	2,500	25	375	0.45	50-100	6 1/2 +/- 1 1/2
A30 Post & rails ³	30	2,500	13	375	0.45	50-125	7 +/- 2
A25 General	25	3,500	25	350	0.45	50-125	6 +/- 2
A25 Paving	25	3,500	25	335	0.49	0-75	6 +/- 2
B20 Massive or lightly re-inforced	20	N.A.	25	295	0.58	0-100	4 +/- 2
C15 Massive Un-reinforced	15	N.A.	25	250	0.71	0-75	4 +/- 2
T20 Tremie seal	20	N.A.	25	375	0.49	75-150	4 +/- 2
Latex hydraulic cement concrete overlay ⁴	25	1,500	13	390	0.40	100-150	5 +/- 2
Silica fume concrete overlay	35	1,500	13	390 ⁵	0.40	100-175	6 +/- 2

¹ When a high-range water reducer is used, the target air content shall be increased 1% and the slump shall not exceed 175 millimeters.

² When Class A35 concrete is used as the finishing bridge deck riding surface, or when it is to be covered with asphalt concrete with or without waterproofing, the air content shall be 5 1/2 +/- 1 1/2%.

³ When necessary for ease in placement, aggregate No. 7 shall be used in concrete posts, rails, and other thin sections above the top of bridge deck slabs.

⁴ The latex modifier content shall be 13.25 liters per bag of cement. Slump shall be measured approximately 4.5 minutes after discharge from the mixer.

⁵ Minimum 7% silica fume replacement by mass of the total cementitious material.

Note: Contractor may substitute a higher class of concrete for that specified at his expense.

